# FIELD MEASUREMENTS OF SEDIMENT TRANSPORT PROCESSES IN STRATAFORM: EXTENDED DURATION OBSERVATIONS

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## LONG-TERM GOALS

The long-term goal is to increase our understanding of the role of physical forcing mechanisms and associated sediment response that contribute to the formation of fine scale strata and cross-margin transport of suspended particulates on the Eel River continental margin.

## SCIENTIFIC OBJECTIVES

The major objective is to carry out a measurement program over an extended period to document fluid motions and sediment transport at selected sites on the continental shelf and slope in the STRATAFORM study area (Eel River, California). The purpose of extended duration observations is to increase the probability of documenting the physical forcing and stratigraphic response to a wider range of major sediment transport events than possible in a single year. Extended duration observations began in September 1995 and have focused on two specific regions of interest along a cross-margin transect seaward of Arcata, California: the sand/mud transition (60 m depth); and the slope depositional region (450 m depth). The measurement program consists of:
1. Collection of a continuous time series of near-bed flow and suspended sediment concentration to document the causes and magnitude of shelf sedimentation events at the sand/mud transition and their linkages to the formation of event beds.
2. Collection of a continuous time series of flow and suspended sediment concentration at three elevations within the water column on the upper slope (450 m depth) to document off-shelf sediment transport and the causes and magnitudes of transport events.
These observations will be used to evaluate the nature of suspended particulate matter being introduced onto the shelf and the processes responsible for its subsequent transport and deposition. Sediment response is being evaluated in terms of frequency of motion, direction of transport, mass transport, and the relationship between suspension events and strata formation. The data are also being utilized by the modeling groups developing strata formation and preservation models.

## APPROACH

1. Platform: Benthic tripod at sand/mud boundary (60 m depth)
Measurements: Current speed and direction at two elevations, waves and tides (pressure), bed elevation and changes (acoustic altimeter), suspended sediment concentration (optical backscatter sensor) at two elevations, in situ particle size (LISST), two video cameras (bed configuration, floc size, and settling velocity), CTD, temperature sensors at two elevations.
Deployment: Two identical tripods are being exchanged every four months beginning on 24 September 1995.
2. Platform: Mooring on upper continental slope (450 m depth)
Measurements: Three identical instrument packages attached at different elevations. Each instrument package consists of (1) an InterOcean $S_{4a}$ electromagnetic current meter, CTD, and

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beam transmissometer, and (2) a time sequence sediment trap. The nearbed array is located 15 m above the seabed, the midwater array is located at approximately 160 m depth (depth of the shelf break), and the near surface array is positioned approximately 60 m below the sea surface. Additionally, ten temperature sensors are spaced over the mooring length to document internal wave activity.
Deployment: Two identical moorings are being exchanged on a six-month interval beginning on 27 September 1995.

## TASKS COMPLETED

Data collection has spanned a two-year period and is still ongoing. Two aspects of the shelf measurement program have been investigated: (1) particle characteristics measured by the floc - camera; (2) sediment transport events occurring over an annual period.

## RESULTS

Analysis of in-situ particle characteristics show that suspended sediment occurs as aggregates with mean sizes ranging from 130 μ (detection limit) to 760 μ. In terms of mass distribution the dominant aggregate size is 600 μ. Component particles comprising the flocs are 0.5% sand, 45.3% silt, 54.2% clay. Settling velocity of the floc population varies from 0.09 cm $s^{-1}$ to 8.13 cm $s^{-1}$ (3.8 cm $s^{-1}$ for the dominant aggregate size).
Analysis of sediment transport events over the first year show a very energetic shelf with frequent suspension events and strong seasonal variability (Table 1).

*TABLE 1. Seasonal Summary of Events*

| | ALL EVENTS | AUTUMN | WINTER | SPRING | SUMMER |
|---|---|---|---|---|---|
| Number of events | 41 (21 south/ 20 north) (35 offshore / 6 onshore) | 15 (8 south / 7 north) (12 offshore/ 3 onshore) | 20 (11 south/ 9 north) (18 off / 2 on) | 5 (1 south/ 4 north) (5 off / 0 on) | 1 (1 south/ 0 north) (0 off / 1 on) |
| Event recurrence | 7.1 days | 3.3 days | 4.5 days | 18 days | 73 days |
| Mean duration | 3.1 days | 1.9 days | 3.1 days | 4.8 days | 7.5 days |
| Mean conc. | 100 mg $l^{-1}$ | 80 mg $l^{-1}$ | 130 mg $l^{-1}$ | 60 mg $l^{-1}$ | 35 mg $l^{-1}$ |
| Peak conc. | 300 mg $l^{-1}$ | 150 mg $l^{-1}$ | 300 mg $l^{-1}$ | 90 mg $l^{-1}$ | --- mg $l^{-1}$ |
| Alongshelf transport | -46200 kg $m^{-2}$ (south) | -1230 kg $m^{-2}$ | -45100 kg $m^{-2}$ | 2960 kg $m^{-2}$ | -2770 kg $m^{-2}$ |
| Cross shelf transport | -38600 kg $m^{-2}$ (offshore) | -4430 kg $m^{-2}$ | -28300 kg $m^{-2}$ | -6180 kg $m^{-2}$ | 390 kg $m^{-2}$ |

## IMPACT ON SCIENCE

These results broaden our views of sedimentology related to energetic continental shelf environments with episodic sediment input. Particles being transported are large aggregates with extremely high settling velocities. The high settling velocity suggests that particles are deposited from the river plume relatively quickly, probably undergo numerous resupension episodes in their transport offshore, and when undergoing transport remain close to the seabed with some evidence of fluid mud formation. This result is supported by physical observations which show frequent wave and current events capable of resuspending sediment and maintaining high concentration nearbed layers through the high river discharge months. Net particle flux is south and offshore supplying sediment to the upper slope and adjacent submarine canyons.

## TRANSITIONS

These data are being used by other groups in STRATAFORM including the shelf and slope research groups and also represents primary input to the shelf and slope modeling groups.

## REFERENCES

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